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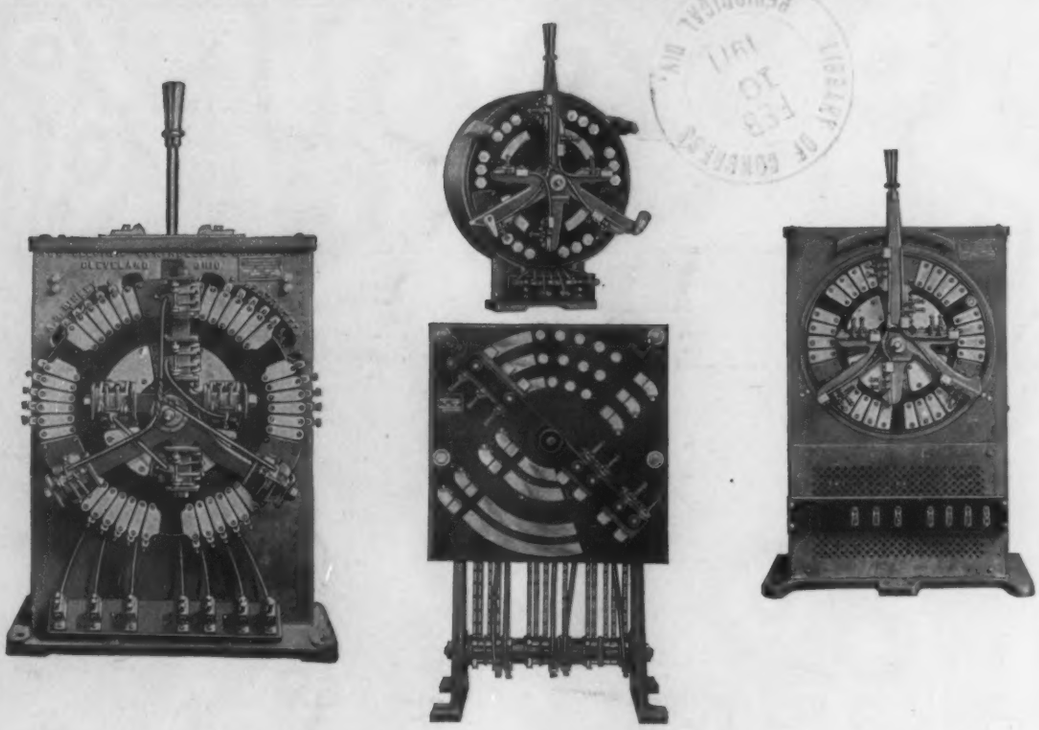

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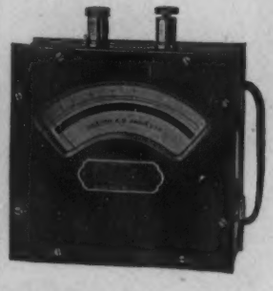

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JHELUM HYDROELECTRIC POWER PLANT[1]

BY HEINRICH HOMBERGER.

The beautiful valley of Kashmir, India, of which Srinagar is the capital, with its colony of houseboats, lies 6000 ft. above the level of the sea, the mountain Haramukh (16,903 ft.) guarding the valley of the Sind, while at a farther distance rises the sacred mountain Mahadeo.

Kashmir was once a lake, and it sometimes suffers now from terrible floods, receiving as it does the rainfall of 3900 square miles and having but one outlet, the gorge of Baramulla to the river Jhelum—the Hydaspes of Alexander the Great. Wular Lake, which is 12½ miles by 5 miles in extent, is said to flow over the remains of a city famed for its wickedness, which was destroyed by earthquake and flood. The boatmen plying on the lake say that the ruins have been seen in the water. Maharaja Sir Pertab Singh holds sway over a territory of 88,000 square miles, some of which is amongst the most fertile in the world, peopled by about three millions. Himself ranking as one of the foremost Hindu princes in India, more than half the population over which he rules is Mohammedan.

Fig. 1. Intake near Baniar. Regulating Basin. Main Sluices. Grid Barrier and Floating Timber Booms.

In 1905 the maharaja was granted fuller independent power of administration by the supreme government of India, and Kashmir bears witness to the wisdom and sense of proportion exercised in its use.

The ruler of Kashmir has applied his knowledge of science, as well as of medicine and law, to the government of the country, and Kashmir is now opened out by a railway system which is to be entirely operated by electricity. The latest and no doubt the largest public-works undertaking just completed in Kashmir is the Jhelum electric power installation.

The report and recommendation of Major de Lotbiniere, R.E., C.I.E.,—by whom the preliminary investigations and reconnaissance survey of the works were completed in 1904,—having been finally accepted by the durbar of Kashmir, it was decided to commence construction in the spring of the following year. The report had located the site of the head works nearly opposite the ancient temple at Baniar, 85 miles on the Jhelum Valley highway, with forebay and power house at Mohora, about 6½ miles farther down, the available working head being approximately 400 ft. The Jhelum Power Division was formed without delay, with headquarters at Baniar, where the old state sawmill buildings and road bungalow were placed at the disposal of the electrical department by the state engineer, which afforded, after some alterations and renovations, suitable accommodation for the resident engineer, divisional office, store and office establishment.

These buildings were subsequently transferred formally, at a valuation arrived at by mutual agreement. By the latter end of May, most of the land required had been taken up and demarcated, and contracts allotted on open tender for the construction of head works, and upper sections of the supply channel, ground being first broken on the 26th of that month, near the head works. Meanwhile, check levels had been taken from the proposed site of the head works to those of the forebay and power house, and the accuracy of the preliminary work in this connection was fully established. Careful and detailed inspection of the supply

[1] Abstract of paper presented to the Technical Society of the Pacific Coast and reprinted from the Journal of the Association of Engineering Societies.

channel alignment along the hillsides showed that a wooden flume presented the only practicable method of conveying the water required over the greater part of the 6½ mile route. The state forest department having undertaken the supply of the whole of the timber (deodar) required, then estimated at 300,000 cu. ft., and details having been settled, indents and full information in this connection were promptly submitted to the conservator of forests. Major de Lotbiniere, C.I.E., left Kashmir for Europe and America on deputation at the beginning of July, 1905, to arrange preliminaries, contracts for the hydraulic and electric plant, and also for plant and machinery required in connection with the proposed dredging operations. Major H. A. D. Fraser, R.E., was appointed as engineer and agent in London to the Kashmir durbar in connection with the Jhelum power installation in June, 1906. Mr. A. C. Jewett was appointed in this capacity from December, 1906, and was located at the Schenectady works of the General Electric Company, New York, whose tender for electrical plant had been meanwhile accepted.

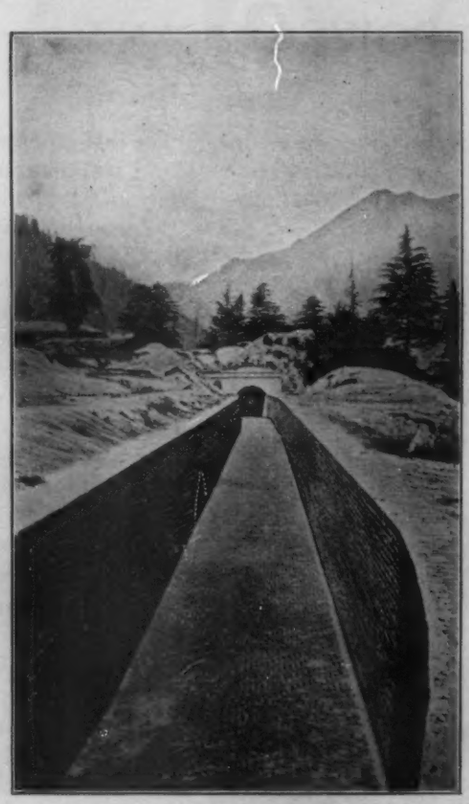


Fig. 2. Intake. Detail of Grid Barrier.

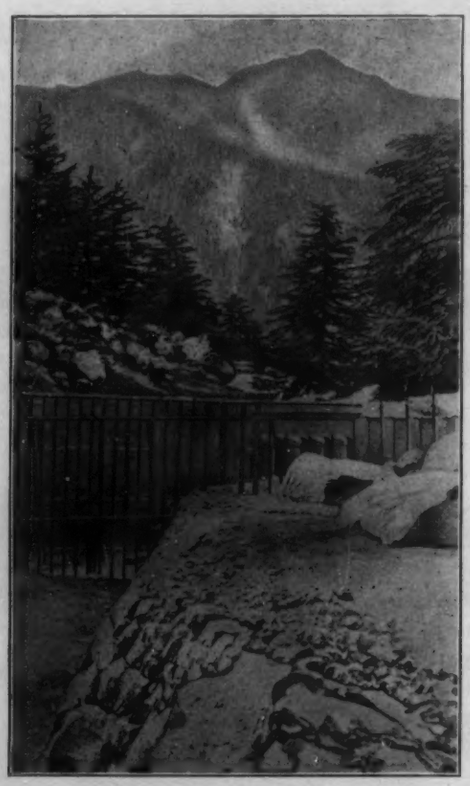


Fig. 3. Masonry-Lined Conduit; in Background the Arched-Over Type of Conduit in "Cut and Cover."

The Development of Water-Power.

The present works, in so far as they relate to the development of water-power, have been constructed to develop 20,000 h.p. at Mohora, of which but 5300 will be utilized at present, the generating plant comprising 4 units only, each of 1000 kw. The site for the head works was fixed finally at a point some 500 ft. above that originally selected, gaining thereby an additional head of about 10 ft., and reducing the excavation on the channel line considerably. The general design is very much like that usually adopted for the head work of an ordinary irrigation canal. It consists of a draft or intake channel, regulating basin and scour sluice, the latter having four outlets, each 4 ft. by 7 ft., with the sill level 2 ft. below that of the lower main sluices.

Of main sluices there are ten, in two tiers, one above the other, for use at high and low river level. These discharge into a small regulating basin, at the contracted end of which a gate 8 ft. wide and 9 ft. high gives admittance to the supply channel. These gates are all of steel, and provided with suitable screw gearing for manipulation. All outlets are protected by heavy iron gratings. A vertical grid-barrier of old rails, erected vertically across the intake channel, together with massive floating timber booms securely anchored, afford further protection from damage by passing timber, vast quantities of which are floated down the river each flood season by the state forest department. The capacity of the main sluices is over 600 cu. ft. per second, with minimum head at low water. During construction a temporary bund was thrown around the site to exclude the river, and constant pumping operations were necessitated during the whole of the working season of 1906, at the end of which the works had been brought well above high flood level. The masonry throughout is of gneiss bowlder stone, obtained near the site, in soorkhee mortar, Portland cement being used in both concrete and masonry of foundations.

Masonry Conduit.

The supply channel takes the form of a masonry lined and floored conduit, and wooden flume; the lat-

ter construction was resorted to only when the former was found impracticable.

The total length of channel is 6.5 miles, made up of

	Miles.
Masonry lined conduit	1.57
Silt basin	0.11
Wooden flume	4.67
Rock tunnel, unlined	0.15
Total length	6.50

A masonry lining was inevitable, owing to the nature of the soil, loose shingle, bowlders, and silt, in irregular formation. The thickness of masonry lining

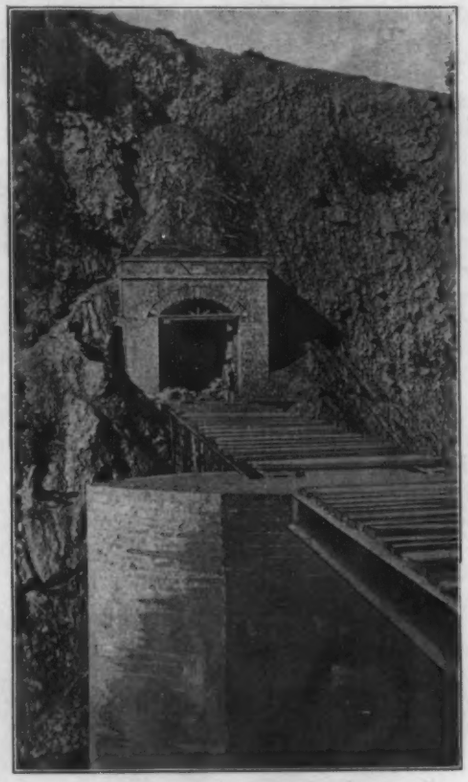


Fig. 4. Tunnel No. 3 Near Chenanwari, and Aqueduct Crossing Gorge.

averages 2 ft., with backfilling of clay concrete; that of the floor being 6 in., all sub-laid with soorkhee concrete of 6 in. minimum thickness. The whole is of coursed stone rubble in soorkhee mortar, and the water-bearing surfaces are pointed throughout with Portland cement. The dimensions of the masonry duct are 11 ft. wide and 9 ft. minimum height, the section is rectangular, with a uniform grade of 1.05 per 1000, this being constant from head works to forebay. The aggregate length of the masonry conduit is 8300 ft., of which 3200 ft. are arched over in "cut and cover." The locations of this type of channel are as follows:

From the head works to the Baniar stream, length of 3400 ft., of which 1000 ft. (chains 7 to 17) lie in very deep cutting, the arched roof being superlaid with earth cover to a depth of from 10 ft. to 20 ft. From the left bank of the Baniar stream to the head of the silt basin there are 450 ft. of cut and cover, with 400 ft. of similar construction below the basin, and 153 ft. of ordinary channel. At Rampur, the masonry conduit recommences at chain 73, in continuation of an interpolated section of wooden flume, passes beneath the Jhelum Valley Road, and across the camping ground of His Highness the Maharaja Sahib to chain 91, being at either end about 1000 ft. long; just below Rampur, chains 102 to 107, the channel forms a subway on a reverse curve, below the bed of a large and at times dangerous nullah. A similar subway passes beneath the bed of a nullah at Chenanwari (chain 257), followed by 150 ft. of arched conduit in cut and cover, and about 200 ft. of open masonry channel immediately beyond tunnel No. 3, at Chenanwari. From the lower end of tunnel No. 6, the masonry con-

Fig. 5. Flume in Course of Construction. Dry-Laid Retaining Wall.

duit runs across the flats of Mohora plateau, for a length of about 13,000 ft., where it debouches into the forebay; this last section is lined and floored in brickwork.

The Wooden Flume.

It was, as already stated, decided at the outset that a wooden flume presented the only practicable method of conveying the water along the steep hillsides, which are of loose formation generally with side slopes ranging from 1 in 2 to 1 in 1, and averaging 1 in 1 1/3. A woodworking plant was imported and installed with two portable engines in a temporary mill at Rampur where the whole of the tongued and grooved planking, etc., for floor and side lining (over one million linear feet) and other miscellaneous work, were dealt with. The rectangular flume frames were all worked up by hand at site. Final alignment having been demarcated, it was decided that the track on which the flume was to be built should take somewhat

the form of an ordinary hill roadway with a uniform grade of 1.05 in 1000. A continuous retaining wall of coursed rubble laid dry, battered 1 in 4 to 1 in 3, supports the hillsides, and a drop wall of similar construction protects the outer edge of the track from erosion, etc. The minimum width of the track is 12 ft. and it is metaled throughout. The dimensions of the rectangular wooden flume are, 8 ft. 4 in. wide and 8 ft. 6 in. between floor and under sides of caps; these are canted at the outer ends in rounding sharp curves to counteract centrifugal wave effect. The minimum radius of curvature on the line is 50 ft., and these curves occur at three points only, viz., Baniar aqueduct, entry to tunnel No. 2, and at No. 6 aqueduct over the Mohora nullah.

The present general watertightness of the flume leaves little to be desired; recent observations, most carefully taken, have shown that the total leakage in four miles of practically consecutive channel of this description is but little more than half a cubic foot per second. The flume has been necessarily roofed throughout to exclude soil, etc., from the hillsides above; this includes also the space between the flume and retaining wall at roof level.

The capacity of the flume is well over 500 cu. ft. per second at full depth of flow (8 ft.) and with a velocity slightly in excess of 8 ft. per second. This is equivalent to over 18,000 h.p. at the power house, Mohora.

Deodar (Cedrua Deodara), from Kashmir forests, has alone been used in construction of the flume throughout, and this cedar is reputed to be about the best of its class in the world. About 700,000 cu. ft. of this material have been used on the work.

The total length of wooden flume is 24,666 ft. (4.67 miles); its building was commenced early in 1907, and by the end of the working season, i. e., December, 1907, 18,600 ft. had been finished. The work was resumed at the end of March, 1908, and carried to completion on the 1st of August, 1908.

The silt basin, a most essential adjunct, has been constructed beyond the left bank of the Baniar stream at a point 4,100 ft. from the head works, below which this was the first suitable site available. It is proposed to install a floating sand pumping plant in the near future, with portable engine, to clear the silt from the receptacle at the bottom of the basin, as may be required from time to time.

The Aqueducts.

Of aqueducts there are five major and five minor, over gorges and small watercourses traversed by the supply channel. Of the major aqueducts, the first is a 76 ft. skew span over the Baniar stream, two-thirds of a mile below the head works. Here the girders, which are of "Warren" type, are inverted, the wooden flume being snugly ensconced between the booms, on the lower of which it is thus carried. This affords maximum headway, which was rather limited, for the passage of timber and driftwood, etc., large quantities of which are swept down this stream at times, during prolonged freshet periods. The waterway immediately above this aqueduct, which was rather confined between rock banks, has been considerably improved by the clearance of an obstructive roof of hard rock. The other four major aqueducts are of similar design, but the girders drop from their bearings, and the flume is carried on the upper boom. The clear spans are in each case 80 ft. and the depth between the boom centers 10 ft; the headway from the bed of the gorge below is from 35 ft. to nearly 60 ft. in the case of the last one at Mohora. These aqueducts cross the Chenanwari and Mohora gorges, together with two large intervening nullahs. There are six tunnels on the line, of aggregate length approximately 2000 ft.

Three snowsheds have been constructed over the wooden flume at points where snowdrifts are known to be exceptionally heavy at times. These, it is hoped, will be found effectual in preventing damage to the flume by snow avalanches. These sheds are situated at chains 117, 123 and 205, between Rampur and Chenanwari, and were constructed from rejected planking and timber poles. It was found during the progress of work that during periods of abnormal rainfall very heavy trees and driftwood, etc., as well as bowlders, are likely to be swept down two ravines, situated about half a mile below Rampur, the flow of water in which is ordinarily quite insignificant. The means adopted to forestall anticipated trouble in this respect took the form of very heavy timber floors or aprons, laid over the flume, of which they are quite independent, and supported by substantial crib-work abutments of logs and stones. The timbers forming these aprons are securely dog spiked and bolted, the floors are flanked, with side walls formed of heavy poles bolted to verticals, in stockade fashion. These over-chutes afford ample clearance way for the largest logs or trees that can possibly be brought down, and they have been in existence, together with the snowsheds, for over two years, with most satisfactory results.

The Power Plant in General.

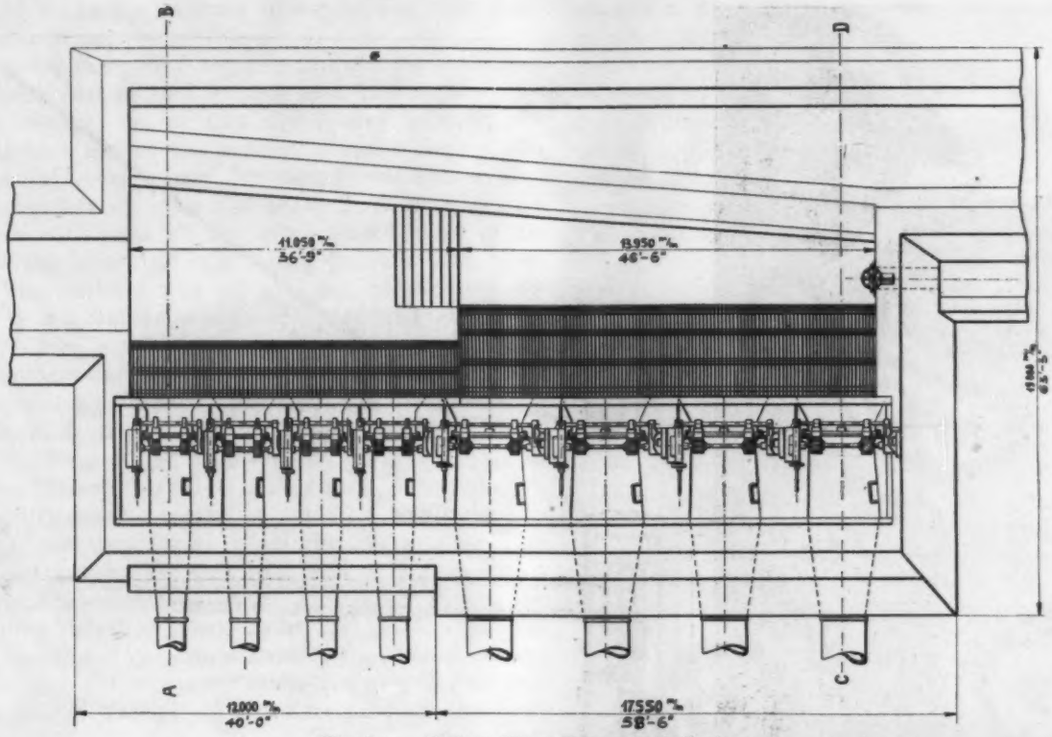
For the design of the power plant proper, consequently also for the arrangement of forebay and pipe lines, three different points of view were of decisive influence.

(1) The fact that the plant was to be located at a point far distant from the origin of the machinery and materials installed, and the impossibility of procuring repair parts without considerable loss of time.

(2) The unfavorable conditions of transportation, as the power plant is accessible only over a mountain road 200 miles long from the railway terminal Rawalpindi, crossing altitudes as high as 7000 ft. above sea level. All material has to be moved by beasts of burden (bullocks); the greatest permissible weight was 4 tons, preferably 2 tons, as the rates for transportation are based on a sliding scale, which goes up rapidly from the 2-ton point. The maximum weights had to be hauled in carts drawn by four animals, two hitched to the front and two to the back of the vehicle.

(3) The power plant was to be installed and operated principally by natives without any experience in this sort of work, and on whose ingenuity, in extraordinary cases, one can count only within moderate limits.

It was decided, therefore, not to go beyond a unit size of 1000 kw. for the first installation of 4000 kw., to make each of the units entirely independent, includ-



Forebay. Jhelum River Power Installation.

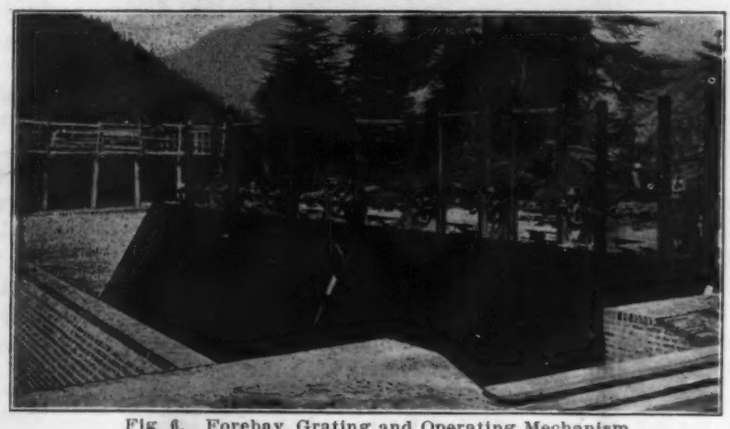
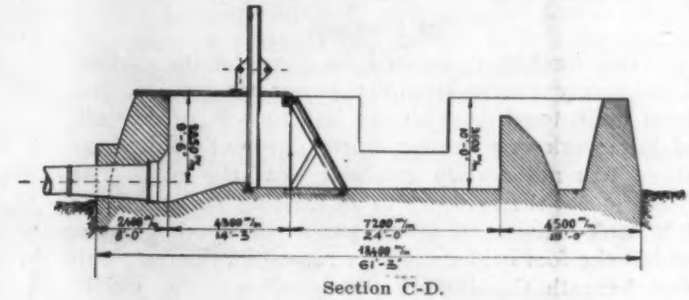


Fig. 6. Forebay, Grating and Operating Mechanism for Main Headgates.

Fig. 7. Installing Pressure Pipe.



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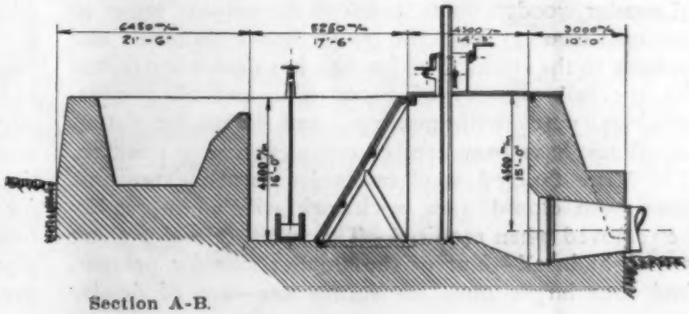

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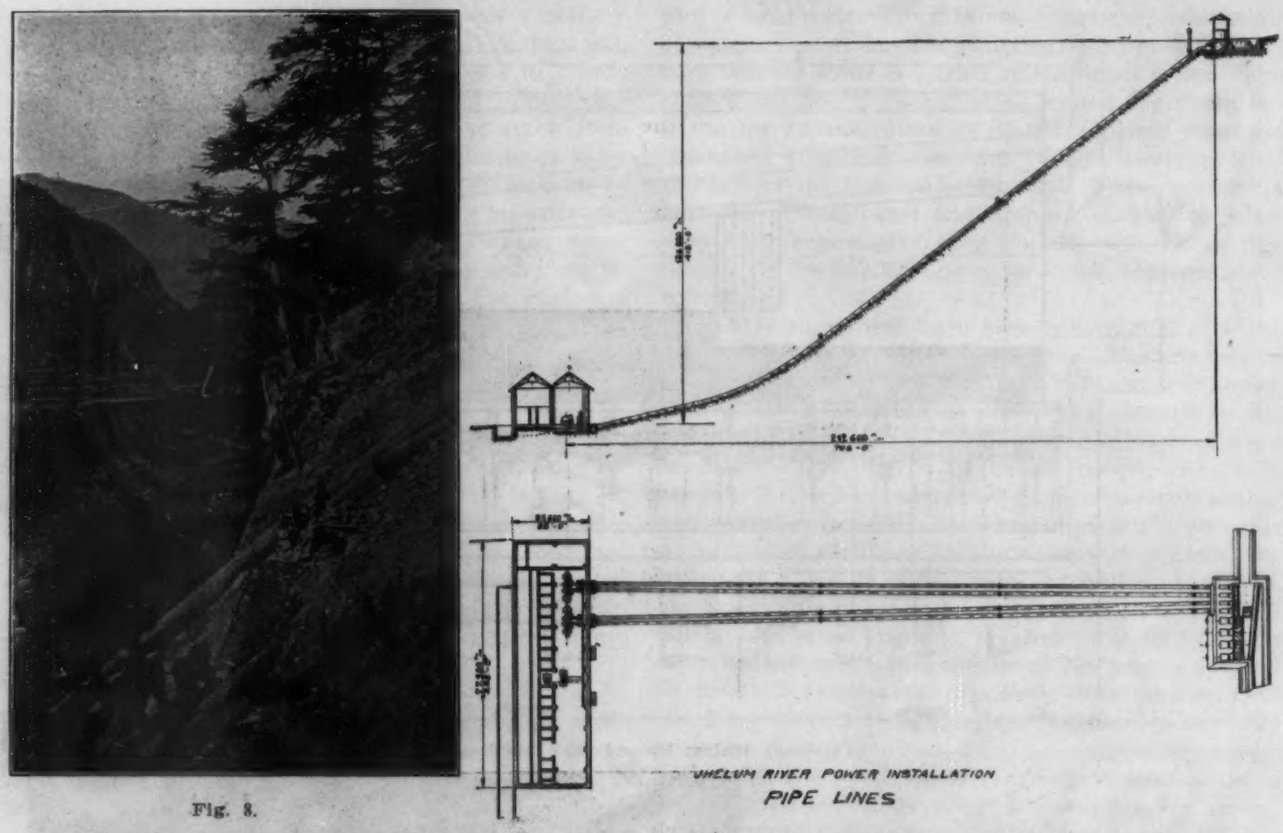


Fig. 8.

ing a separate pressure pipe, main gate valve near the machine and sluice gate at the forebay. For the proposed extension of the plant, however, pipe lines of larger capacity have been planned, each of which would be sufficient to feed two 1000 kw. units. If the Jhelum Valley Railway should be completed in time for the next following installation of generating apparatus, a larger size of units may also be considered.

The exciter units take their water from a double header pipe, running along the uphill wall of the power house building. This is connected with the main pipe lines by means of special valves. The small motor generator set, to be mentioned later, and the fire service also, connect with this double header.

The Forebay.

The forebay is located on the Mohora plateau immediately overlooking the power station. It has been built, together with the last 1000 ft. of conduit, of brickwork in soorkhee mortar, cement pointed, as stone was not readily available near the site. The extension of the spillway to an existing nullah on the left flank consists of about 500 ft. of wooden flume, and at the foot of the nullah a capacious masonry culvert beneath the Jhelum Road, followed by 300 ft. of similar wooden flume, conveys the surplus water to the spill channel from the power house tailraces, and so back to the river. The forebay has been constructed for the full capacity of 20,000 h.p., and all fittings, gratings, gates with gearings, and inlets for future pipe lines, have been erected complete and in position. The large tapered steel inlets for future extensions have been closed with brickwork which can readily be removed when required. The gates, of which there are eight in all—four of the smaller size for present, and four larger ones for future use—are of deodar wood, made at site; the metal fittings, gearings, etc., for manipulation were imported.

Each gate controls and isolates a separate chamber containing the bell-mouth inlets, which perforate the outer main front wall, giving admittance to the penstock pipes. The bed of the nullah, on left flank of the forebay, being liable to heavy scour, it has been recently decided to spill from the aqueduct over the Mohora nullah, some 1500 ft. higher up the channel, where the bed of this nullah is of very hard rock.

The Pressure Pipes.

Each of the pressure pipes is 750 ft. long, with no horizontal curves, and two bends in the vertical plane are made in the form of welded angle sections. One of the joints near the entrance taper is a slip joint, packed with hemp, in order to permit possible longitudinal movement of the pipe line.

The pipes are made of welded steel, each section is 10 ft. long between the rows of rivets which form the circular joints. The diameters are reduced three times, beginning with 36 in. at the top, and ending with 30 in. at the lower end, the thickness of the plate increasing from 5 mm. to 8 mm. Each course has two longitudinal welding seams, made by the water gas process, and is tapered to the double thickness of the plate, so that every course fits the next following one. The ends of each course were carefully finished and fitted at the works and provided with calking edges; all rivet holes drilled from templates, and every course was tested hydraulically to one and one-half times the static head. The welded seams were tested for tightness by tapping with a short-handled sledge hammer while the pipe was under test pressure. All pipes were coated inside and outside with a rust-preventing compound, and carefully marked before

shipment, so that a mistake in assembling was practically impossible.

For shipment, four sections of different diameters were telescoped into each other and held in place by wooden wedges driven into the spaces between the pipes at each end of the bundle. Finally the ends of the bundles were closed by heavy wooden covers, drawn together by means of three threaded half-inch iron rods with nuts. These were placed close to the inside of the innermost or smallest diameter pipe. Owing to this careful way of packing, which also resulted in a great reduction of space and saving in freight, these light pipes stood the long trip with transshipment at four places, Hamburg, Bombay, Karachi and Rawalpindi, very well, and arrived at the plant in perfect condition.

The laying of the pipe lines began from the bottom; the bottom section of each pipe is provided with a welded flange by means of which it was bolted to a heavy cast-iron fitting of slight curvature. This fitting has a soleplate cast to it and acts as a thrust block, being bolted to a heavy foundation pier. The entire pipe thrust is taken up at that point. To prevent a dangerous vacuum in case of the sudden emptying of a line, automatic air inlets are provided at two points; also a standpipe immediately below the forebay.

The material for the pipe lines arrived in 1907, well towards the end of the season suitable for pipe laying; nevertheless, work was started immediately, and when it had to be stopped in December, all four lines had been finished as far as the Jhelum Valley Road, under which they pass through tunnels, about 156 ft. from the power house. Early in April, 1908, work was resumed, and the installation was finished by the first of August, simultaneously with the completion of the flume.

Where the pipes are exposed they are carried on brick piers, which are 20 ft. apart.

The Power House.

The very heavy excavation in difficult hard bowlder soil, that had necessarily to precede the commencement of the power house, was begun towards the end of 1905 and was completed in June, 1906. The design for the building was adopted after determining present limits as regards length, etc., and adapting details to local requirements. The steel trusses for the roof were procured from Bombay. The building was laid out early in July, 1906, and brought to its main floor level by the end of the working season. It was eventually completed—that is, in the matter of walls, roof, and doors and windows—by end of November, 1907.

The foundations and superstructures to the gallery level, i. e., 20 ft. above the main floor, are of coursed rubble masonry, and the walls above this of mortar class brickwork, all in soorkhee mortar. All concrete and mansonry work in the tailraces and wheel pits, etc., is in Portland cement soorkhee mortar. Concrete was used in all ordinary foundations, etc.

The main floor consists of 6-in. soorkhee concrete, with Portland cement surface rendering; the gallery floors are of Portland cement concrete 7 in. thick, with expanded metal reinforcement; the whole is carried on steel beams, of suitable sections and spacing.

The roof consists of galvanized iron corrugated sheeting, 22 B.W.G., laid upon 1 in. kairoo planking, over common rafters and purlins of similar wood, the whole supported by steel trusses of French type, spaced at 12 ft. 4 in. centers. The roof is double, in two spans, one of 39 ft. 2 in. and one of 40 ft. 2 in., with central valley gutter and down pipes at gable ends.

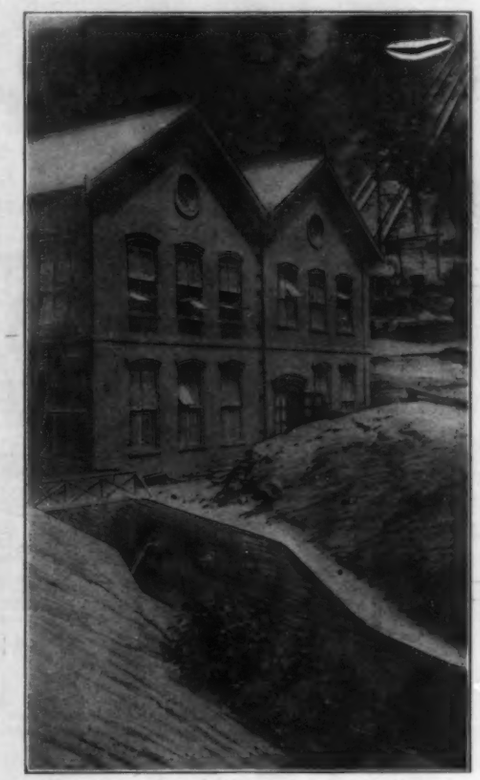


Fig. 10. Power House Building (end view) Tailrace.

The internal dimensions of the building are 183 ft. 6 in. long and 76 ft. wide at main floor level. Two additional tailraces and foundation pits for four more machines of similar size to those now installed, together with six extra transformer compartments, have been provided within the existing building. Should any deviation from the existing type of machines be made in future installations, these foundation pits, etc., can be readily adapted. A spacious machine shop has been provided at the east end of the power house, with an adequate outfit of machine tools and motor-driven shafting, etc. This portion of the building also contains a complete oil-treating plant and a specially constructed pit, to facilitate work upon the main transformers. This generating plant began to arrive late in 1906, by the end of which little more than some line material had been received. Further arrivals accumulated in Rawalpindi during the winter, when the roads to Kashmir are usually closed to heavy traffic by reason of snow. In the spring, however, carting was resumed, and so well maintained that practically the

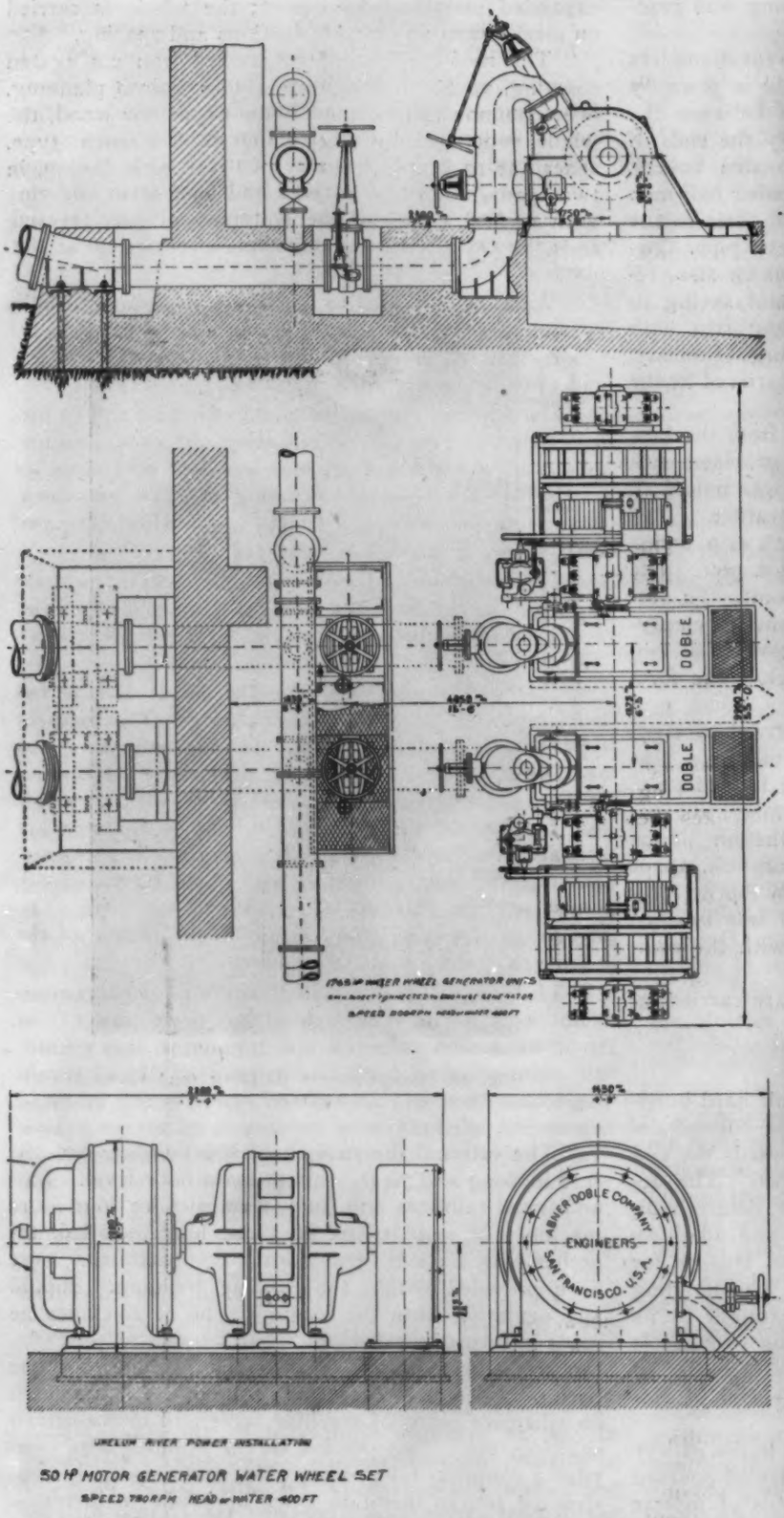


Fig. 9. From Roof of Power House.

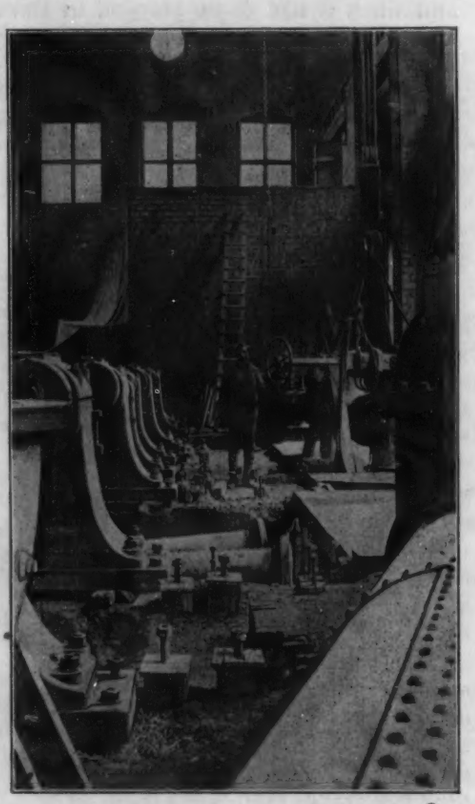


Fig. 11. Power House Interior. Bearings for Main Generating Units. Exciter Header Pipe in Background.

whole of the plant had been delivered by the end of 1907.

A substation at Srinagar has been erected on a suitable central site, within the state silk factory enclosure.

Hydroelectric Machinery.

The machinery so far installed in the power house consists of the following items:

4 main generators, 1000 kw. 2300 volts, 60 cycles, 500 r.p.m.

4 main water-wheels, 1765 h.p., 500 r.p.m.

6 transformers, single-phase, delta-connected for 30,000, 50,000 and 60,000 volts.

2 exciter generators, 150 kw., 125 volts, 500 r.p.m.

2 exciter water-wheels, 275 h.p., 500 r.p.m.

1 motor-generator water-wheel set, 50 h.p., 125 volts, 720 r.p.m.

Water-Wheel Units.

As mentioned before, the main generators are of 1000 kw. rated capacity, and the water-wheels, mounted upon the same shaft as the rotor fields, develop a maximum of 1765 h.p. In order to reduce size, weight and cost of the units, a turning speed of 500 r.p.m. had been selected, although slower speed machines would have given a higher efficiency. This high speed required the application of two jets, plying on one single water-wheel runner.

The main shaft is carried in two bearings of 11 in. and 8 in. diameter respectively, the generator is located between the bearings and the water-wheel runner is mounted on one extended end of the shaft. The generator rotor was pressed upon this shaft after arrival at the plant; the water-wheel runner, cast in one piece, is bolted to a flange, forged upon the end of the shaft, by fitted bolts.

Water is conveyed to the machine from below; the main supply pipe is located below the floor; it has a diameter of 24 in. and is equipped with a main gate valve of the same opening; it is carried up through a 90-degree elbow and terminates in a casting forming a double nozzle in such a way that one jet strikes the wheel horizontally below the shaft and the other one from above it at an angle of 60 degrees from the horizontal. Both nozzles are equipped with regulating needles for hand operation.

The instantaneous regulation is accomplished by cylindrical jet deflectors, and these are operated simultaneously by a vertical Lombard oil governor. This form of regulation in itself does not afford any economy in water consumption, but it was resorted to principally by reason of its simplicity, and, furthermore, cheap labor permits of an ample operating crew in the plant, so that hand operation of the needles and starting and stopping of entire units can be carried to an extreme, which in a plant in this country would rather overtax the operators.

The water-wheel housings are entirely of cast-iron, and, for the purpose of cutting down the weight of the single pieces, and also for facilitating the erection, they are made in four parts. In order to permit a ready inspection of wheels and nozzles, man-holes with bolted-down covers are provided at the side of the housing.

The main bearings have shells with cylindrical support, lined with anti-friction metal. Rack-teeth cast in the outside of the bottom shell make it possible to rack it around the shaft and to remove it without the necessity of lifting the rotor and shaft out of the bearings. All that is necessary is to transfer the weight of these parts upon temporary blocks.

The governors have a pressure and vacuum tank cast with the frame; the oil pump also forms an integral part of the governor, and like, the pendulum, is belted directly to the main shaft.

It is apparent that each unit is homogeneous and independent, from the forebay to the switchboard.

Of the two exciter units (for a third one, foundation pit and pipe connections are provided) either one is sufficient to energize four of the main units. In general design they are identical with the main units, but generator, bearings and base form one element of the unit, and the water-wheel was pressed upon the extended generator shaft after arrival at the plant.

Water is conveyed to the wheel by a single needle nozzle, operated directly by a Lombard hydraulic governor. The latter is mounted upon the nozzle casting and takes its water from the main pipe line.

For the operation of solenoid switches, and to furnish direct current for various other purposes, a motor-generator-water-wheel set was installed in a chamber under the switchboard, consisting of a d.c. generator, an induction motor and a 50 h.p. water-wheel equipped with a needle nozzle for hand operation.

A double line of twenty-one miles length connects the plant with Baramulla, and from there it is continued as a single line to Srinagar (thirty-three miles). The present voltage is 30,000.

The old "jhula" over the Jhelum at Baniar has been replaced by a suspension bridge of permanent type, and a good light bridge of steel wire rope has also been erected just above the power station at Mohora. These have been constructed with materials that had served their purpose on the works, and are primarily intended to facilitate access to the transmission line (the vital importance of which can be hardly overstated) in this, its most difficult section. The bridges at the same time confer on the people of the locality a much-appreciated boon.

The whole of the unskilled, and a large proportion of the skilled, labor throughout has been drawn from Mohora, Srinagar, Poonch and Jammu, so that a number of the subjects of His Highness the Maharaja Sahib have derived substantial benefit in the shape of remunerative employment on these works during three years. Most of the contractors also were residents of Kashmir and Jammu. The whole work, including the erection and installation of plant, both hydraulic and electric, was practically completed on August 15, 1908.

The cost of the entire plant to date has been about $825,000, including transmission lines and distributing system.

The entire electrical equipment was furnished by the General Electric Company, of Schenectady, N. Y., the entire hydraulic equipment by the Abner Doble Company, of San Francisco. The former was shipped from New York via Suez, the latter partly the same way, partly from San Francisco via Hongkong; the pipe lines, from Hamburg via Suez.

Slide rule calculations of pipe discharge can be readily accomplished from the formula $Q = d^2 \sqrt{d} \sqrt{h}$ where Q is the discharge in cubic feet per second from a pipe d inches inside diameter laid at a grade of h feet per thousand.

STREET LIGHTING.

BY WYNN MEREDITH.

With the advent of the tungsten lamp the problem of economic and satisfactory street lighting, particularly in residence and suburban districts, has been greatly modified. The low efficiency of the old carbon incandescent lamp made its use expensive and unsatisfactory as compared with arc lamps placed a considerable distance apart. The disadvantage of the arc method of street lighting in resident districts where trees and dense foliage obstruct the direct rays from

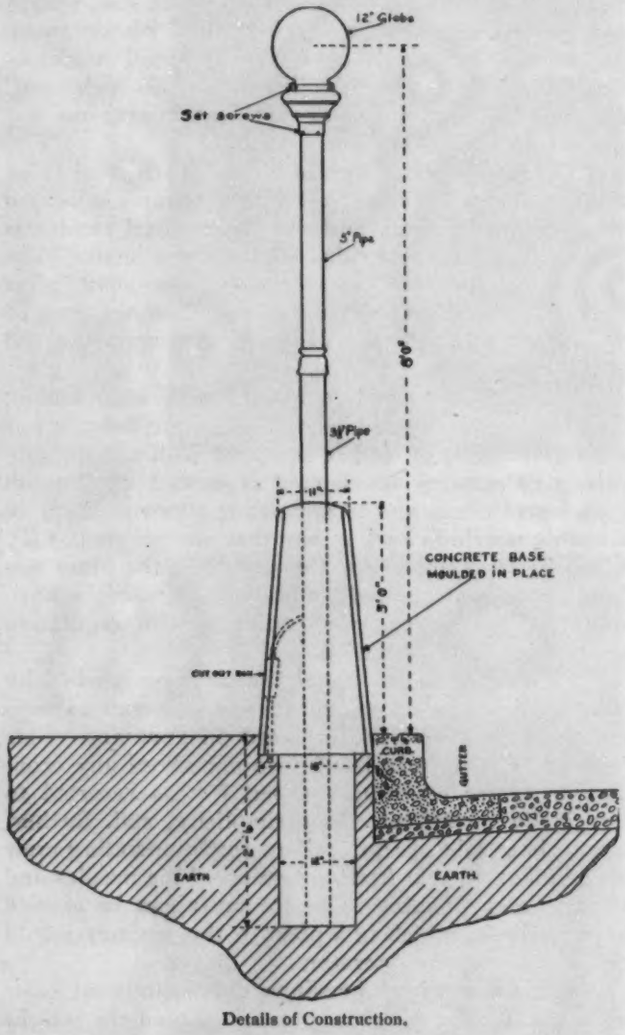
The Alameda Post.

the high hung lamps is apparent, even though arc lamps are placed at each intersecting streets, the middle of the blocks and more particularly the sidewalks are frequently dark and practically without any light at all. The incandescent lamps of the old filament type permitted of a good distribution, but their low efficiency is such as to make the cost of sufficient illumination excessive. The tungsten lamp not only gives a much higher efficiency, but yields a superior quality of light and in both respects closely approaches the arc lamp.

One of the principal difficulties has been the cost of distribution and installation of the ordinary electrolier. This problem has recently been solved in the Alameda, Cal., municipal plant by the construction of a home-made electrolier that has proved in an experimental installation to be quite satisfactory.

On account of the fragility of the tungsten lamp it is of the greatest importance that the lamp support be substantial and rigid to avoid even slight vibrations, which result in an early destruction of the standard voltage tungsten filament.

In the Alameda post, which is not particularly ornamental, massiveness and exquisite rigidity are obtained by means of a cement base, the upper part of the post consisting of ordinary gas pipe with a cast-iron globe holder located 8 ft. above the curb. As a city ordinance requires trees to be trimmed slightly above this height, the light from the post is unobstructed over the entire surface of the street and sidewalks. Posts have been placed about 75 ft. apart on opposite sides of the streets, making the spacing on each side 150 ft. and at the intersection of streets



Details of Construction.

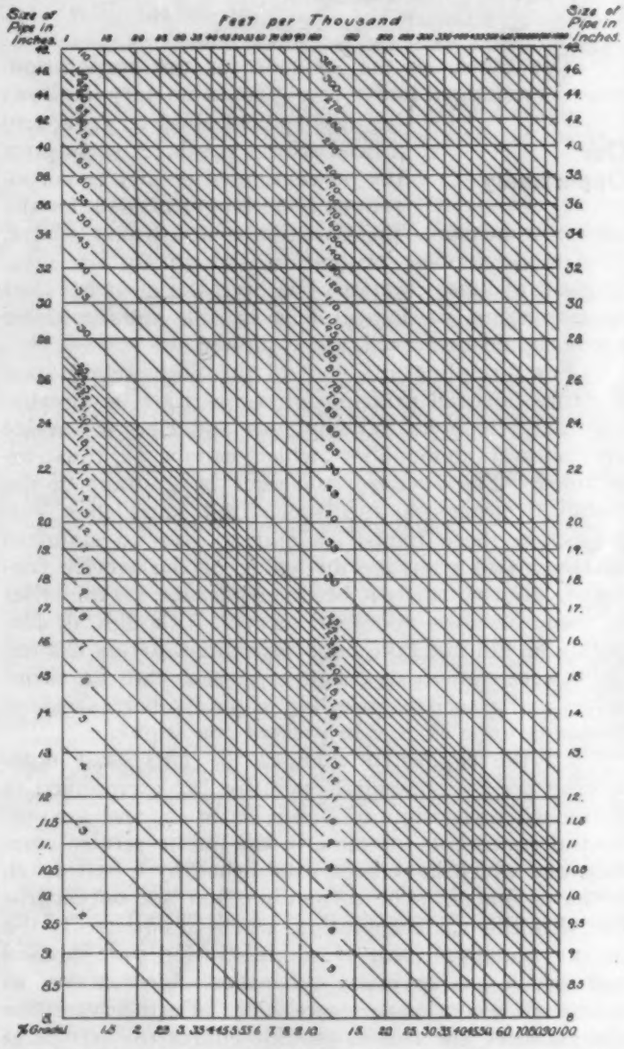
two are placed, one on opposite diagonal corners. The ordinary 110 volt, 60 watt lamp is used connected in parallel and served from a pole transformer connected to a special 2300 volt constant potential street circuit. Each transformer serves the lamps for two blocks each way, the wires being carried down the pole and distribution to the lamps being made under ground with ordinary galva-duct buried a few inches below the sod in the parking between the curb and sidewalk. An outlet box with cover is imbedded in the concrete base, to facilitate the drawing in of wires and to house a double pole fuse block.

Each lamp post costs about $10 erected, and the total cost of the installing including ducts, wiring and painting, is about 20 cents per front foot, or 40 cents per lineal foot of street. This is a remarkably low cost for an electrolier system with underground wiring.

FLOW OF WATER IN PIPES.

BY A. H. HALLORAN.

The accompanying diagram gives a close approximation to the amount of water in cu. ft. per sec. that will be carried by a given sized pipe laid with a given grade, expressed either as ft. per thousand or as per cent. It is calculated for old cast iron pipe but for sizes above 16 in. may be used for riveted steel pipe. The capacity of new pipe is 1.4 greater.



A single example will suffice to show the simplicity of the method. How much water will be carried by an 18 in. pipe a mile long when there is a difference in elevation of 160 ft. between the beginning and end of the pipe? This is practically a 3 per cent grade. The vertical lines show per cent grade, the horizontal lines the pipe size. The oblique line through their intersection gives the flow in cu. ft. per sec. Consequently, following up the 3 per cent vertical line until it intersects the 18 in. horizontal line we find the oblique line showing 15 cu. ft. per minute discharge.

The most economic size of pipe to carry pumped water according to a formula developed in Engineering-Contracting may be determined from the formula $X = 75\sqrt{Q}$ where X is the inside diameter of the pipe in inches and Q is the number of cubic feet of water pumped per second.

EXPERIENCE IN THE SHOP.

BY H. ALTMAYER.

A contractor who had been using a donkey engine to pull a sand drag decided to substitute an electric motor, the high cost of coal being the deciding factor. He accordingly rented and installed a 35 h.p. single phase motor. Unfortunately this would not pull his 2½ yd. scraper 350 ft. a minute, bringing the voltage from 220 down to 180 volts before pulling out of step. As current was transmitted at 2300 volts through five miles of No. 4 wire the electric light company put in a 10 per cent booster and installed 75 kw. transformer capacity, but even then the motor would just haul the empty scraper taking 43 kw. at 205 volts.

As a larger single-phase motor could not be obtained it was decided to couple on another motor by means of two driving pulleys on the jack shaft. There was available a 15 h.p. type C three-phase Westinghouse 1120 r.p.m. motor made when the company was putting in higher grade steel, but still employing the old quantity. This was thoroughly tested with single-phase current, the voltage being raised to 330 and from these tests curves were drawn to show the magnetizing current, iron losses, efficiency and speed. A good point was found on the curve except for rotor losses. After these had been segregated by calculation into bar losses and ring losses it was found by reinforcing the rotor ring that the motor would pull 32.5 brake h.p. at 1165 r.p.m., this being the manufacturers rated full load speed of the single-phase motor and of the three-phase motor reconnected to give the effect of 330 volts when 220 volts were applied.

As the type "C" motor had no starting torque on single-phase it was brought up to speed with the other motor and then thrown on the line. It was found that due to excessive line drop the commutator type of motor had a smaller break down point, and would carry its share of load up to about 30 kw. at 190 volts and the "C" motor would be taking 25 kw., but on heavy load, such as the scraper being caught in the sand, the "C" motor would do more than its share, holding up till the varnish began to run out of the coils and carrying 45 kw. at 185 volts.

An old 10-kw. transformer was stripped of its high tension coils and four sets of 30 volt windings wound on the secondaries, and the commutator type of induction motor was made to carry its part of the load by boosting its voltage to 240 volts, while the other got 210 volts, at which one carried 43 kw. and the "C" 32 kw. on the forward pull at 350 ft. per min. and 25 and 20 kw. for the empty bucket at 500 ft. per minute, it requiring 2.5 minutes for the round trip.

This combination rig was operated successfully for four months, after which they desired to move their hoist 200 ft. As they were doing the moving by power off, the 200 ft. of No. 00 motor line were left on the sand until it could be reset. The next day they telephoned that the motors would not pull their load and it was found that because of extra slack in the line they had coiled each wire separately and hung it on an iron telephone pole step. The consequent choking effect was sufficient to prevent getting good results. After stretching out the lines, the outfit operated until the job was completed.

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Panama-Pacific Exposition

Congressional endorsement of the Panama-Pacific Exposition practically assures the success of this undertaking which is destined to bring the Pacific Coast before the eyes of the world in a most favorable manner. Electricity's part in this exposition is to be the most important ever assigned to this convenient form of light and power. The fair means more people to buy more power in every Pacific Coast community.

Our Opportunity

The State, as the sponsor for the corporation, must be adjudged guilty of neglect of its duty in allowing this spoiled child to grow into a head-strong youth. A society for the prevention of cruelty to corporations is no longer needed, for the case now demands the attention of the truant officer. The public service corporation, though not the most recreant of these creations has been the most heedless in estranging its logical friends, the public, whose needs should be served, not exploited.

For discipline and control the State relied upon the time-honored principle of competition, not realizing that telephone, railway, gas and electric service are natural monopolies which cannot be thus restrained. The average consumer is ignorant of the technical processes and specialized knowledge employed in these industries and so has no standard wherewith to compare the value of the service rendered. Consequently it becomes possible for the seller to name his own price and terms. Although all corporations did not take base advantage of this chance, there were enough shortsighted ones to earn for themselves and associates a feeling of public distrust which demands some change in present conditions.

Of the suggested changes the two most noteworthy are governmental operation, as exemplified in municipal ownership of public utilities, and governmental control, as effective in the public service commissions which have been established by a half dozen or more States. The former method not only curbs but also kills the corporation, which is admittedly the most economical form of administration ever devised and which has so many other desirable features as to make its continuance advisable. Furthermore few communities are able to provide equivalent service at equal rates for the same cost to the taxpayer. For a graft-ridden city to operate any public utility is the height of folly .

Rate regulation by local municipal boards has proved a signal failure for over thirty years in California which was the first State to adopt this form of control. National regulation is impracticable in this great country of diversified interests, so the only feasible suggestion is a public service commission. The purpose of such a commission is to protect the rights of the people by establishing fair rates and improved service. Many corporations do not require such an incentive to give satisfaction to their patrons. Those that oppose a public service commission may be temporarily embarrassed by its rulings but, if these are fairly given, will find that the ultimate result will be a financial stability and public confidence of inestimable value.

PERSONALS.

A. M. Hunt returned to San Francisco during the past week after a business trip to Portland.

J. B. Clarkson, of the Western Electric Company's sales department, is making a tour of Central California.

R. E. Danforth, president of the Public Service Railway Company, of East Orange, N. J., is a San Francisco visitor.

F. G. Baum, of F. G. Baum & Co., returned last Tuesday from an engineering investigation in the Sacramento Valley.

H. L. Jackman, manager of the Humboldt Gas & Electric Company, of Eureka, was a San Francisco visitor during the past week.

George I. Kinney, Pacific Coast district manager of the Fort Wayne Electric Works, is making a tour of the Pacific Northwest.

F. B. Gleason, manager of the Western Electric Company's Pacific Coast branch, left last Tuesday on a trip to Salt Lake City.

Frank P. Clark is sales engineer for Chas. C. Moore & Co., engineers at Honolulu where a large number of Hammell oil burners are being installed.

J. M. Ough, who is interested in a hydroelectric project on Kings River, has been confined to an Oakland hospital recently, with a case of appendicitis.

H. H. Noble, president of Northern California Power Company, returned last Wednesday from an inspection tour of the transmission lines in Shasta County.

Thomas Mirk, of Hunt, Mirk & Co., Pacific Coast representatives for the Westinghouse Machine Company, returned to San Francisco from San Diego last Monday.

W. S. Turner has resigned as managing engineer of the Portland, Ore., office of W. S. Barstow & Co., whose several contracts in that vicinity are about completed.

A. W. Whiteford, a steel manufacturer of Bethlehem, Pa., and Knox Taylor, the head of the Taylor Iron & Steel Works, of Highbridge, N. J., were recent San Francisco visitors.

W. B. Foshay has resigned as manager for the Pacific Power & Light Company at Walla Walla, Wash., to accept a similar position with the Washington Oregon Corporation at Vancouver, Wash.

C. E. Thatcher, who recently arrived on the Pacific Coast from the East, has just been appointed City manager of the Western Union Telegraph Company at San Francisco to fill the vacancy created by the resignation of W. A. Newcomb.

Elam Miller has been appointed commercial engineer of the Pacific Telephone and Telegraph Company, reporting to the general commercial superintendent, vice C. F. Mason, who has taken the position of district commercial superintendent of the Los Angeles district.

Louis C. Kelsey, of Salt Lake City, Utah, has opened an office in Portland, Ore., as consulting engineer, and will give special attention to the design and construction of waterworks systems, hydroelectric plants, irrigation, sewers and sewage disposal systems, and pavements.

Louis W. Hill, president of the Great Northern Railroad and interested in the Oregon Electric system extending from Portland up the Willamette Valley passed through San Francisco this week on his way to Los Angeles. He has announced that extensions of the electric railway lines will be made including one from Salem to Eugene, Ore.

F. S. Cromise, manager of the new business department of the Pacific Gas & Electric Company, is in the East.

W. J. Massee, president of the electric power and street railway company at Macon, Ga., is at San Francisco with a party of Eastern capitalists on a tour of the Pacific Coast.

A. H. Hull, who has charge of the General Electric Company's testing laboratory on Bryant Street, San Francisco, recently returned from a Northern California trip.

William A. Newcomb who was appointed San Francisco city manager of the Western Union Telegraph Company about four months ago, resigned during the past week and left for Washington, D. C., to re-enter the service of the State Department in a more important capacity. During his stay in California, Mr. Newcomb won the high esteem of both his fellow officials and his employees besides improving the local service.

A. S. Grenier, heretofore general manager of the Pacific Power & Light Company, has been elected vice-president of that company, in charge of operation and construction. James E Davidson, who has been new business manager of the company, has been appointed general manager. Both officials have headquarters in Portland. H. R. Kingman has been made local manager of the North Yakima branch, vice H. F. Way, who has been appointed assistant to the chief engineer.

Paul Shoup, general manager of the Pacific Electric Railway of Los Angeles, has announced the following department heads effective Feb. 1, 1911. J. McMillan, general manager in charge of the operating department, Geo. E. Pillsbury, chief engineer in charge of construction, E. C. Johnson, assistant chief engineer in charge of maintenance of way; D. W. Pontius, traffic manager in charge of all traffic affairs; S. A. Bishop, general claims agent; George L. Bugbee, land agent of the Pacific Electric Land Company and related companies; W. V. Hill, tax and contract agent; Fred F. Small, mechanical engineer; H. A. Culloden, auditor; S. H. Anderson, electrical engineer; M. S. Wade, cashier; W. G. Sherlock, assistant cashier.

TRADE NOTES.

The Vulcan Electric Heating Company has established offices at 1100 Military Road, Buffalo, New York, also maintaining their office and stock at 542 West Jackson Boulevard, Chicago, Ill. Increased manufacturing facilities have been acquired and the company is now better equipped than ever before to take care of their customers' requirements on Vulcan products.

The Pelton Water Wheel Company recently sent a gang of men to Chile to start the work of a new pipe line for the hydroelectric plant at the Baden Copper Comany's mines. A superintendent of construction will follow them to take charge of the installation of the water wheels.

MEETING NOTICES.

The next meeting of the Portland Section, American Institute of Electrical Engineers, will meet on February 21 in the Electric Building, when E. L. Ritter of the Pacific Telephone & Telegraph Company, will speak on "Telephone and Telegraph Work."

The next meeting of the Los Angeles section of the American Institute of Electrical Engineers will be held at Blanchard Hall, 233 So. Broadway, on Tuesday, February 21st, at 8 p. m. Professor A. W. Nye of the University of Southern California will present a paper on steam turbines. Visiting members are cordially invited to be present.

NEW CATALOGUES.

In Bulletin No. 4809, recently issued by the General Electric Company, is described that company's Type F, Form K-3 oil-break switch.

The Washington, Baltimore & Annapolis 1200-volt, d.c. railway is detailed in Bulletin No. 4808 from the General Electric Company.

Paragon Bulletin No. 2 from the Paragon Sellers Company presents some new facts about grounding with particular reference to the Paragon ground cone.

The January, 1911, number of the J-M Packing Expert, in addition to its usual valuable suggestions about high pressure steam packings, contains as a new feature an Anti-Trouble Column.

Bulletin 5 C from the national engineering department of the National Electric Lamp Association is devoted to tantalum multiple lamps, 100-125 volts and 200-250 volts, 25, 40, 50 and 80 watts.

Electric Sign Lighting is the subject of Bulletin 15 from the engineering department of the National Electric Lamp Association, giving data on performance, economy equipment and applications of "Mazda" and carbon sign lamps.

Bulletin 8 B from the engineering department of the National Electric Lamp Association illustrates and describes "Mazda" miniature and low voltage lamps for automobile, signs and other battery uses for voltages from 1.5 to 20.

Straight air-brake equipments are illustrated and described in Bulletin No. 4798, recently issued by the General Electric Company. This bulletin should prove of interest as well as of service to all connected with street railway work.

Catalogue No. 463 from the Sprague Electric Company contains a complete list of Sprague conduit products conveniently arranged for quick use. These include iron-armored insulating conduit and fittings, knockout and outlet boxes and covers, and flexible steel-armored conductors and fittings.

Catalogue H from the National Tube Company is a 470-page volume comprising material manufactured at their Kewanee works and embracing wrought pipe for steam, gas water and air, cast, malleable iron and brass fittings, valves and cocks, radiators and coils, and drive well points and well supplies.

The General Electric Company has just issued Bulletin No. 4685, which is a revision of a previous bulletin on belt-driven alternators. The alternators illustrated and described in this publication are of the revolving field type and range in capacity from 30 to 550 kw. The bulletin contains dimension diagrams of the complete line.

Bulletin No. 4785, recently issued by the General Electric Company, is devoted to the subject of electric drive in wood-working plants and advantages to be derived from the use of electric motors in this industry. The bulletin illustrates and describes the electric motor as a part of wood-boring machines, drills, jig saws, rip saws, band, circular and swing saws, planers, etc.

A publication which should prove of interest to those connected with the manufacture of paper is Bulletin No. 4784, just issued by the General Electric Company, and devoted to electric drive in pulp and paper mills. The advantages to be derived from the use of electric power in this industry are set forth in the bulletin, and descriptions of a number of important installations are also included.

The Western Electric Company has just issued Bulletin No. 1006, describing non-multiple toll switchboards. The boards described are divided into two general types, those having self-restored line signals and those with manually-restored line signals. Considerable space is devoted to the combined jack and signals used with the first type of boards. The bulletin, which contains thirty-six pages, is illustrated with many photographs and diagrams and contains a table showing the capacity of standard types of non-multiple toll switchboards.

Steady vs. unsteady voltage is the title of Bulletin No. 4793 from the General Electric Company. This publication illustrates and describes regulators for controlling the generator voltage and also those for regulating the feeder voltage. There are reproductions of curves showing voltage with and without regulators installed. The bulletin illustrates installations of both types of regulators.

Bulletin No. 4804, recently issued by the General Electric Company, is a revision of the company's previous bulletin on direct connected generating sets. These sets, while originally designed to meet severe conditions of marine work, are also well adapted, and have been used extensively for both power and lighting in isolated plants, and as exciters for alternating current generators in central station work.

The General Electric Company has developed a line of air compressors having piston displacements of from 15 to 100 cubic feet per minute. These compressors are portable and were designed for use where the installation of a system of piping is not feasible. These sets are mounted upon three-wheel trucks which can easily be moved from one place to another. A detailed description of these sets is given in Bulletin No. 4810.

Air compressors are illustrated and described in Catalogue No. 549 from the Platt Iron Works Company, Dayton, O., particularizing on Smith-Vaile air compressors, both steam and power driven in single and duplex simple and two-stage types. Catalogue No. 555 from the same company is devoted to Smith-Vaile general service pumps both steam and power driven. Chas. C. Moore & Co., engineers, are general Pacific Coast representatives.

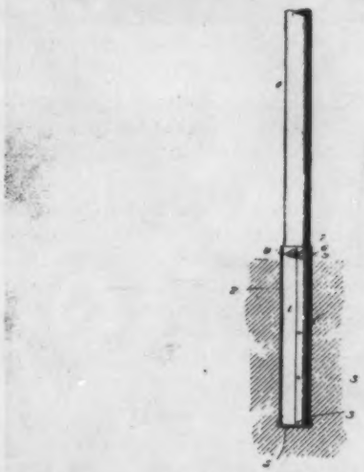
Bulletin No. 4807, recently issued by the General Electric Company, illustrated and described panels designed for use in small or isolated plants containing but one generator. The bulletin describes panels of two sizes, 76 and 90 inches, the only difference in the two sizes is that the larger panel contains the necessary apparatus for controlling a constant current transformer. The publication contains dimension and connection diagrams.

Bulletin No. 9465, describing the Moore light for color matching, has just been issued by the Western Electric Company. This is declared to be the only artificial illuminant which gives exact daylight color values, and it is being introduced into shops, mills and other establishments where color values are of great importance. The white Moore light is a radical new form of the electric light. It is a vacuum tube electric light produced by the passing of alternating currents through highly rarified carbon dioxide gas confined within a continuous clear glass tube. The bulletin contains a description of this illuminant and of its uses and operation. A page is devoted to the list of concerns now using this, and another to tabulated dimensions, data, etc.

In a new 48-page catalogue recently issued by the Lagonda Manufacturing Company of Springfield, Ohio, (Chas. C. Moore & Co., Engineers, Pacific Coast agents), is discussed the relative advantages and different conditions under which it is most suitable to use the various types of boiler tube cleaners. Besides boiler tube cleaners, other boiler room devices are briefly described, such as the Lagonda water strainer for removing impurities from boiler feed or condenser water, the automatic feeding device for removing scale from Stirling boilers without entering the drum, the Lagonda double action cut-off valve for automatically shutting off steam in case of break in the line, besides other devices such as tube cutters, reseating machines, etc.

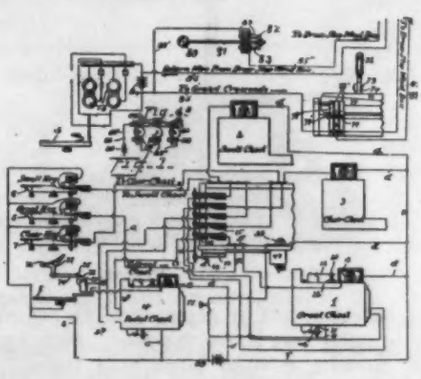
PATENTS

982,380. Electric-Pole Stand. David A. Martin, Republic, Wash. In a support for poles or the like, the combination with a flexible, metallic tubular casing adapted to be permanently set in the earth and serve as a stand and to directly receive the pole and provided with a split upper part adapted to



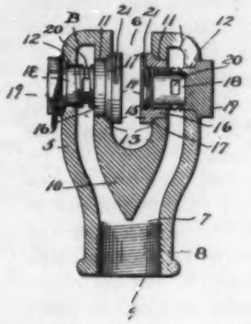
directly engage the pole, of a clamp independent of and slidable on said split upper part of the support and adapted to be located at any desired position to cause said split upper part to clamp the pole to the casing subject to release and removal of said pole without disturbing the casing.

982,419. Electrically-Operated Organ. William B. Fleming, Los Angeles, Cal. In an organ the combination of a great wind box; a wind channel having an exhaust, said channel being communicable with said wind box; a pneumatic; valves actuated by said pneumatic to control the communication of said wind box with said channel and the exhaust therefrom; a wind channel communicable with said pneumatic and with



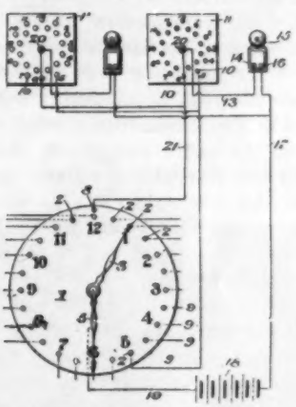
the great wind box, said channel having an exhaust; a second pneumatic; valves actuated thereby to control the communication between the wind box and the channel leading to the first pneumatic and the exhaust from said channel; a channel leading from said second pneumatic to the open air; an electro-magnet to control said last channel; means to operate said electro-magnet.

982,424. Liquid-Fuel-Burner Tip. William F. Goodwin and Joseph C. Low, San Francisco, Cal. A burner tip comprising a fluid conveying element including spaced walls, said walls having openings therein, a nozzle member engaged in one of the openings, and a nozzle fastening member engaged through the other opening and connected with the nozzle member, said nozzle fastening member being hollow, and



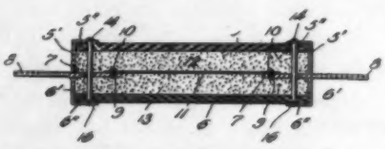
having passages communicating with the interior of the nozzle member, and with the interior of the conveying member, for the passage of fluid from the conveying member through the nozzle member.

982,495. Electric Time-Alarm for Hotels, etc. George M. Hinman, Lindsay, Cal. An alarm system consisting of a main circuit closing clock provided with contacts, dials with contacts corresponding to those on the clock, connections between the two sets of contacts, batteries and alarm devices in



the circuit of said connections, an auxiliary contact on each dial, a detachable plug normally engaging said auxiliary contact to connect the same in circuit, an auxiliary contact on said clock, and means to form a connection between said clock auxiliary contact and the other clock contacts to close a plurality of alarm circuits.

982,738. Inclosed Fuse. Charles R. Moellendorf, Seattle, Wash. An electric fuse comprising complementary shell parts of insulating material complementary cap elements of conducting material mounted upon the ends of the respective shell parts, a fusible element, tongues extending inwardly and



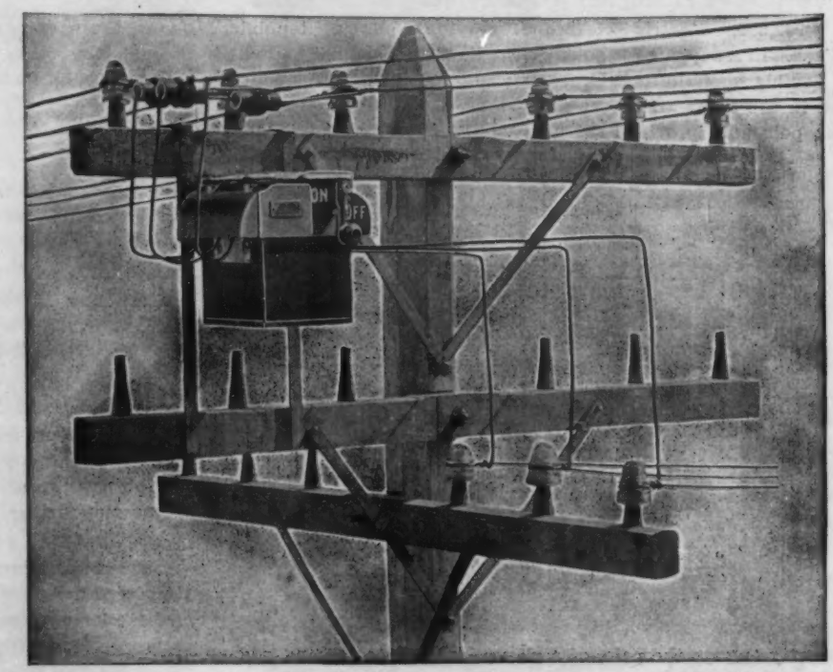
outwardly from the cap elements of one of said shell parts, means for detachably connecting said fusible element to the inwardly-extending tongues, and means extending through the inwardly-extending tongues and the shell parts and their caps for detachably securing the said elements together.

INDUSTRIAL

TYPE F, FORM P, OIL BREAK POLE LINE SWITCH.

BY D. S. MORGAN.

Owing to the magnitude and complexity of the electrical distribution systems of the present day, it is important in many cases that means be provided for cutting portions of the circuit in or out of service by suitable devices installed at points which necessarily must be remote from the station. Such a device must be designed for installation out of doors and for operation under load, and would find application in sectionalizing feeder systems, cutting in and out transformers and in similar service. In many cases, the use of this switch in connection with a transformer will obviate the necessity of bringing high tension lines into the building. To meet this demand the General Electric Company have designed an oil break switch which is simple, introduces no complications in wiring, and, on account of the convenient construction of the frame and method of supporting, is easily installed. It can be mounted on a flat surface or, by use of strap iron hooks, on transmission pole cross arms in a manner similar to that usually employed for mounting pole type transformers.



General Electric Non-Automatic Oil Break Switch Designed for Pole Line Service.

This pole line oil break is thoroughly weatherproof. It is entirely enclosed in a cast iron frame, fitted with a removable cover, grooved on the under side to fit closely to the edge of the frame and supplied with a suitable gasket which prevents damage to the mechanism due to weather conditions. A detachable oil vessel, with insulating line and barriers between the switch poles, fits around a flange at the bottom of the frame. The stationary contacts are flared fingers of drop forged copper, supported from the contact blocks of the copper current carrying studs, by a heavy flat steel frame. The studs are supported by and insulated from the frame by porcelain insulators. The movable contacts are wedge shaped copper blades hinged at one end. They are actuated by specially treated wooden rods connected to the shaft which in turn is operated by the crank and handle outside of the frame. The construction of the stationary and movable contacts is such that any burning, due to rupturing the arc, is confined to the tips of the stationary contact fingers and the upper extremity of the movable contacts, preserving the actual current carrying surfaces. This feature of construction insures clean contact surface and uniform contact pressure without retarding the opening of the switch.

This switch is built in sizes up to 200 amperes at 15,000 volts. The method of bringing the leads to the switch varies somewhat according to the voltage, but in every case they enter through porcelain bushings protected from the weather by the overhang of the frame. The switches up to 4500 volts are designed for use with insulated wire, while for voltages between 4500 and 15,000 bushings are furnished which allow the ure of bare wire.

BENJAMIN MILL CLUSTER.

In line with the activity for improved conditions in the matter of industrial lighting, the Benjamin Electric Manufacturing Company of Chicago, have placed upon the market a cluster fixture which is intended to replace arc lamps in mills, factories, foundries, etc.

The illustration shows Cat. No. 0664½ with 24 in. enameled steel concentrating dome reflector for meeting requirements where it is necessary to hang the light units sufficiently high to clear traveling cranes. A second form, their Cat. No. 0684½, has a 24 in. enameled steel flat cone

Benjamin Mill Cluster.

distributing reflector, and is designed to be suspended from twenty-five to thirty feet above the floor. Both fixtures have sockets for 250-watt (S-40-B) large base lamps. They are furnished wired in series for 220 volt circuits or series-multiple for 110 volt circuits. A reflected light volume of approximately 1500 c.p. is secured.

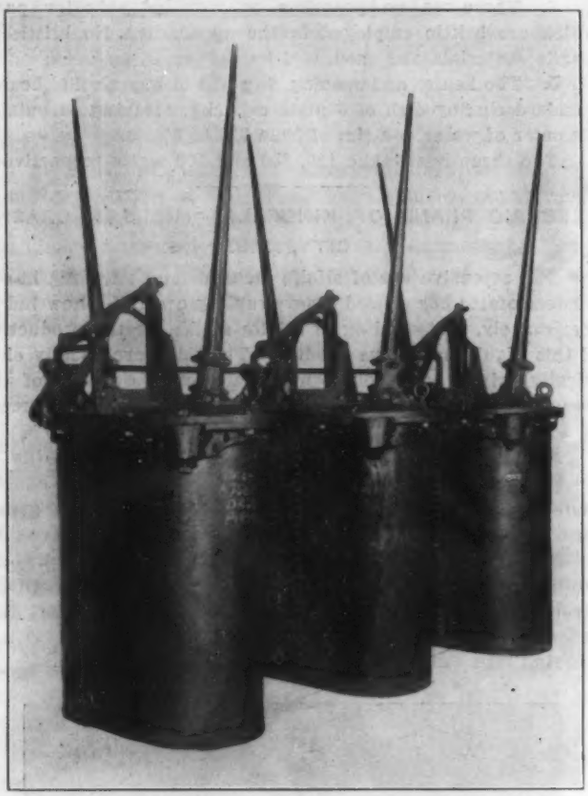
The manufacturers have a Mill Cluster Bulletin giving curves showing the light distribution, together with tables furnishing data on single cluster unit illumination, or the cumulative illumination of a plurality of single units, in foot candles. Copies may be secured on application.

A catechism on direct current apparatus has been issued by Fairbanks, Morse & Co., Chicago, giving, in simple language, definitions for electrical terms and describing the construction and uses of different electrical machines.

HIGH TENSION CONDENSER TYPE TERMINALS.

A new type of terminal for high tension apparatus has recently been developed by the Westinghouse Electric & Manufacturing Company utilizing a principle not used for this purpose before.

The terminal is constructed of alternate concentric insulating and conducting layers, forming a series of condensers which serve to make the distribution of potential stresses in the insulating material uniform and thus increase dielectric strength of the terminal. As a result a much smaller terminal can be used for a given voltage with a corresponding saving in cost of the entire piece of apparatus and a gain in dependability under conditions of abnormal stresses due to surges, lightning and similar causes.



Oil Circuit Breaker Equipped With High Tension Condenser Type Terminals.

It can be readily seen that any terminal passing through a metal tank forms in effect a curved condenser, the plates of which are the surface of the terminal and the surface of the hole or bushing in the tank. The insulation between the two is the dielectric of a condenser and is subject to all the conditions affecting such a dielectric. It can be shown both mathematically and experimentally that the static stresses in the dielectric of a curved condenser are not uniform throughout the thickness, but are greatest near the inner surface. Therefore the thickness of the insulation must be made such that the inner layers will not be subjected to dangerous stresses, which result in the outer layers being thicker than necessary. Looking at the matter in another way, if the insulation is designed for a certain voltage per inch of thickness, there will be danger of breakdown due to the higher stresses near the inner surface. For low voltages the unnecessary thickness of insulation, is not important, but for voltages of 70,000 and over the ordinary insulator becomes so large as to necessitate an increase in size of the entire apparatus.

By interposing the metal layers, the difference in diameters of the plates of each condenser is reduced and the distribution of the potential made more uniform, which results in a saving of unnecessary thickness of insulation. An idea of the saving effected can be had by a comparison of two terminals designed and tested for 200,000 volts. An ordinary bulk type terminal for this voltage is about 9 ft. in length and 16 in. in diameter including insulation. A condenser type terminal for the same voltage is 7 ft. in length and 4 in. in diameter, the volume of the former being 8 times the latter.

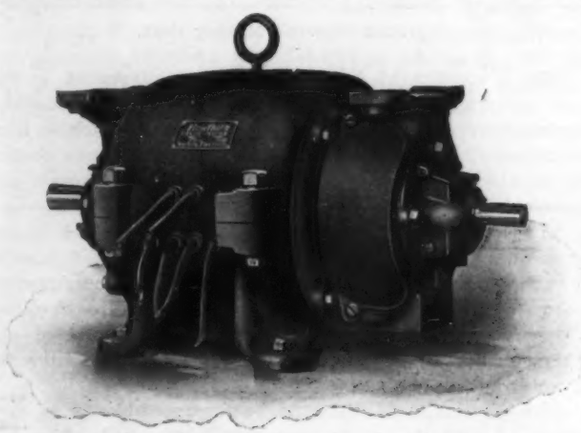
The condenser type terminal is constructed by winding the successive layers on a central outlet tube. The insulating layers consist of a special grade of paper wound under pressure and cemented and pressed together into a solid mass without weak spots. On each thickness of insulation is wound a layer of metal foil. The layers are so finished that each is shorter than the one beneath it, thus tapering the terminal and providing a creeping surface between successive conducting layers. The creeping surfaces on the end projecting into the air are, naturally, larger than those at the end submerged in oil. A heavy metallic flange is fastened to the outside of the terminal to serve as a support for mounting it in the tank.

The illustration shows a 60,000-volt oil circuit-breaker equipped with condenser type terminals. The Westinghouse Electric & Manufacturing Company supply these terminals with all high voltage transformers, circuit-breakers, electrostatic voltmeters and similar apparatus.

A NEW CRANE MOTOR.

A new direct current, reversible and totally enclosed crane motor, known as the "Western Electric" Hawthorn type HLA, has just been placed on the market. This motor combines high electrical efficiency with a compact and rigid construction, which insures absolute reliability under the severe conditions common to crane and hoisting service.

These motors are of the totally enclosed, split frame type, and are built in sizes ranging from 1¾ h.p. at 1375 r.p.m.



Western Electric Type "H L A" Crane Motor.

to 50 h.p. at 525 r.p.m. The frame is cylindrical in form and of small diameter, requiring minimum head room and reducing the moment of inertia of the revolving parts. The frame is cast of soft steel and designed with a low center of gravity and ample feet surface for rigidly bolting in place. The upper half of the frame may be lifted after removing six or eight bolts, depending upon the size of the motor. This leaves the armature and bearings intact. The heads are not split, but can be lifted out after removing the upper half of the frame and the bolts which secure the heads to the lower frame. This leaves the motor practically disassembled.

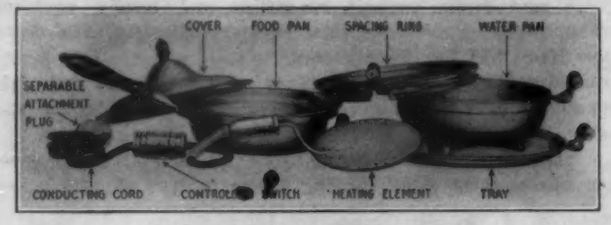
The motor heads which are held in place by four bolts are provided with brackets for the mounting of the back gear shafts and brake pads for the addition of magnetic

brakes. These motor heads are adjustable, which permits of the motor being mounted in various horizontal positions.

The laminated pole faces which are cast with the frame are securely bolted to the poles. This eliminates iron losses and insures cool operation. The bearings are of the self-oiling, revolving ring type and their surface is provided with bronze linings. This arrangement insures the efficient lubrication and good wearing qualities necessary for heavy duty. The armature core and commutator are mounted on a quill to facilitate easy removal from the shaft without disturbing the windings. The commutator, coils and brush holders are of the latest improved design and are made for heavy duty.

A CHAFING DISH WITH AN IMMERSION TYPE HEATER.

It is well established that the efficiencies of resistor materials for heating devices cannot be improved. The best energy developed by the passage of an electrical current through a resistance will always equal I^2R. Obviously, several resistors of different materials, all having the same resistance, through which a current of a certain value flows will each develop precisely the same amount of heat. Improvements in the efficiencies of electric heating devices must, then, come through the effective utilization of the heat that is produced by the flow of electric current through heating elements. The efficiencies of the elements themselves cannot be improved. Every reasonable precaution should, in the efficient heating device, be taken to prevent the loss of the electrically generated heat.



Exploded View of Chafing Dish.

The principles of heat conservation advocated in the above paragraph are embodied in the construction of the new Westinghouse electrically heated chafing dish which is illustrated herewith. This device consists of an ordinary chafing dish to which is added a Westinghouse disc-type heater and a spacing ring to provide for its admission.

The heater is of the disc-immersion type and is immersed in and is wholly surrounded by the water in the water pan. Evidently, all of the heat developed must be imparted to the water. There can be no losses of heat through direct radiation from the heater. The water pan is nickled and highly polished which retains losses from radiation from the hot water at a minimum.

The Westinghouse disc-type heater resembles somewhat a stove lid with its handle permanently attached. The conductors to the heating element are carried up through the "handle" which is called the lead arm. A specially prepared cord, a telescopic 3-heat control switch and a separable attachment plug are permanently attached to each heater. The resistors (heating elements) in Westinghouse disc-type heaters are hermetically welded between the sheet copper plates which form the two surfaces of the disc. The resistors are in intimate contact with, although thoroughly insulated from these two plates. This construction effectively prevents oxidization and insures that the temperature of the heating element will never rise more than a few degrees above that of the outside of the heater and of the liquid in which the heater is immersed. The Westinghouse disc-type heater is not in any way fastened in the water pan and can be readily removed for cleaning at any time. The heater can be used for heating liquids is any vessels that will contain it. Any alcohol heated chafing dish of the usual size can be equipped for electrical operation by the addition of a heater and spacing ring which is slotted to provide for the admission of the lead arm to the heater. Both of these parts are sold separately or in combination with a chafing dish by the Westinghouse Company.

Disregarding the matter of thermal efficiency, the following advantages are claimed for the Westinghouse chafing dish:

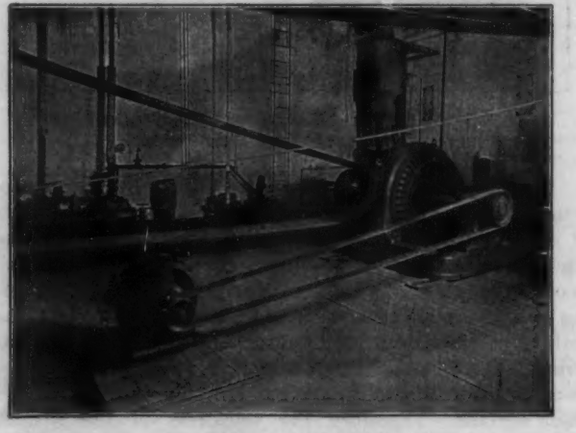
1. All parts are readily accessible for cleaning.
2. The heater can be used for heating liquids in any vessel that will contain it.
3. If through oversight the water is allowed to boil entirely away the heater will operate in air, at normal voltage, for an indefinite period without harm.
4. There are no porcelain or moulded asbestos parts which are brittle employed in the apparatus. No brittle or fragile materials are used.
5. The heater and spacing ring will fit any alcohol heated standard chafing dish of 3 pints capacity. Having an outside diameter of water pan rim of from 8¾ to 9⅜ in.

The three heats take 125, 250 and 500 watts respectively.

ELECTRIC PLANT OF KINGFALFA MILLS, NEBRASKA CITY, NEB.

The extensive use of alfalfa meal for stock feeding in our western states has caused a very rapid growth of a new industry; namely, the grinding of alfalfa stalks for the production of this highly nutritious product. The mills are usually electrically driven and they form an attractive example of the way in which electric power contributes to the development of a new industry.

A typical installation is that of the Kingfalfa Mills at Nebraska City, Neb. Their plant consists of a 300 k.v.a., 440-volt, 600 r.p.m., 3-phase, 60 cycle, alternating current generator of the two-bearing, belt-driven type; this is driven by a 300 h.p., simple, non-condensing Corliss engine, and the power developed is used to drive a disintegrator or alfalfa meal mill and other auxiliary machines, such as blower, dust collector, packer, etc. The alfalfa mill is driven by a 150 h.p. slip-ring type motor, which is belted direct to the mill.



Electric Plant of Kingfalfa Mills.

On account of the great weight of the mill and the inertia of the moving parts a high starting torque is required to start and bring it up to speed, which is a severe test on the capacity of both the motor and generating plant.

The capacity is four tons per hour of the finished product, and in a test of several hours continuous operation has been worked to the capacity of six or seven tons per hour. The entire electrical equipment was manufactured and installed by Fairbranks, Morse & Co., through their branch office at Omaha, Neb.

NEWS NOTES

INCORPORATIONS.

SAN FRANCISCO, CAL.—The Sierra-Blue Lakes Water & Power Company has been incorporated by Eugene J. Sullivan, Walter E. Sullivan and Geo. H. Richardson, with a capital stock of $75,000.

SAN FRANCISCO, CAL.—The La Sierra Heights Water Company has been incorporated by J. E. Coberly, Edwin Higgins, A. B. A. Briggs, H. G. Hubbard, and J. O. Smith, with a capital stock of $1,000,000.

REDWOOD CITY, CAL.—The Sierra and San Francisco Power Company has filed amended articles of incorporation. The principal place of business has been changed to Millbrae. The capital stock of the company is $20,000,000 and the directors are: J. S. Thornton, Winfield Dorn, H. F. Jackson, Geo. H. Whipple and W. Gregory.

SAN FRANCISCO, CAL.—Articles of incorporation of the California Power & Manufacturing Company, capitalized at $5,000,000, have been filed by F. G. Baum, Charles W. Slack, Chauncey S. Goodrich, George H. Ray and John T. Pigott. The company proposes to own and operate water plants for power, lighting, irrigation, electricity and heating in Northern California.

TRANSMISSION.

CHELAN FALLS, WASH.—Power stations will be established at Entiat and Chelan Falls in the spring by George D. Brown of this place.

NORTH YAKIMA, WASH.—The Pacific Power & Light Company has applied to the county for a franchise for 30 miles of pole line to supply power and light for its telephone properties.

EUGENE, ORE.—The Oregon Power Company is asking proposals for materials to be used in construction of the power plant at Martin Rapids on the McKenzie river. Manager Spencer is now on his way to Chicago to confer with officials as to other work.

BISHOP, CAL.—F. B. Mechling, commercial agent for the Nevada-California Power Company, from Goldfield, has made a trip through southern Inyo and lower Owens Valley and signed up business for the company prospective toward the extension of the power lines down the valley.

OROVILLE, CAL.—According to H. H. Sinclair, general manager of the Great Western Power Company, the only work that will be done this year will be the addition of another unit to the power plant at Big Bend. This work will cost in the neighborhood of $200,000.

SPOKANE, WASH.—According to D. L. Huntington, president of the Washington Water Power Company a new power house will be built on the Spokane River this side of the recently completed Little Falls unit, and there is a transmission line to be built from the plant to Spokane.

PLACERVILLE, CAL.—Engineers have prepared a camp at Chili Bar on the south fork of the American River for the complete survey and platting of the power-site ditch right and other interests at Chili Bar owned by John Pearson of this city, and now under bond to the Sacramento and Sierra Railway Co. The engineers are under Civil Engineer J. A. Graham of Berkeley. A few weeks ago John P. Fisher, former county clerk of El Dorado County and now a trusted agent of the Sacramento and Sierra Railway Company appropriated 5000 miner's inches of the water of the south fork of the American River and it is now apparent that the appropriation of water will be used for the purpose of the development of electricity. That the Sacramento and Sierra Railway Company is considering the enterprise of constructing a great power plant for the generation of power to operate its cars is evident.

FINANCIAL.

NEWPORT BEACH, CAL.—The City Trustees last week offered a resolution of intention to call an election to vote for the purchase of a gas and electric light system for Newport. The electric light company places a valuation of $15,000 on its plant. The Board decided to make a bond issue of $55,000, interest 5 per cent, and to pay off two $1000 bonds each year after five years had elapsed. It will not take the amount named to purchase the plants but the Board wants to have bonds voted and then sell them as they are needed.

PORTLAND, ORE.—The American Power & Light Company, of 71 Broadway, New York, have purchased the Hood River Light & Power Company, of Hood River, Oregon, a company owning a generating plant on Hood River, and supplying the town of Hood River with power, light and water. The following new officers have been elected for the Hood River Company, and hereafter it will be operated by the same management as the Pacific Power & Light Company: President, Guy W. Talbot, vice-president, A. S. Grenier; secretary and treasurer, Geo. F. Nevins; assistant secretary and treasurer, Lewis A. McArthur; general manager, James E. Davidson. The new officers of the Hood River Company will be in the Spalding Building, Portland, Oregon. The American Power & Light Company already controls the following companies in Oregon and Washington: Pacific Power & Light Company, Portland Gas & Coke Company, Walla Walla Valley Railway Company and Hanford Irrigation & Power Company, all of which have headquarters in Portland. It is understood from press reports that a 66,000-volt line will be built by the Pacific Power & Light Company from its present plant at The Dalles, westward along the Columbia River 22 miles to Hood River, in order that the Hood River Light & Power Company may have additional power service to fall back on in case of emergencies. It is also reported that additional development will be made at Hood River, and that more distribution lines will be built in the Hood River Valley.

TRANSPORTATION.

MARSHFIELD, ORE.—It is announced that the Lane County Asset Company has financed 20 miles of electric road from Eugene to Florence.

BELLINGHAM,, WASH.—The Chamber of Commerce has recommended that the city subscribe sufficient funds for the construction of the first nine miles of the Nooksack Valley Traction & Railway Company.

MISSOULA, MONT.—Local business men are considering the construction of a Missoula-Kalispell electric railway line across the Flathead country and of an electric road through the Frenchtown and Grass Valley countries.

SAN BERNARDINO, CAL.—Preparatory to linking this city with Los Angeles via Riverside, the San Bernardino Traction Company has commenced to tear out its roadbed along Third street, replacing the track with 100 pound rails. The entire system throughout the valley will be replaced with heavier rails.

PORTLAND, ORE.—Application for a subway franchise has been made by the chief engineer of the Baker Interurban Railway. It provides for a complete street car system in addition to the bore under the Willamette river.

PORTLAND, ORE.—John F. Stevens, president of the North Bank Railroad, announced that only two electric roads will be built in Oregon this year, one is the Eugene extension 75 miles long, extending to the coast. Contracts for construction will be let at once. The other road is the Tillamook line.

SACRAMENTO, CAL.—The people of the city who live in the vicinity of C street, between Nineteenth and Twenty-seventh streets, have sent a petition to Mayor M. R. Beard requesting him to urge the Northern Electric Railway Company to extend its local service line up C street, from Eighteenth to Twenty-fifth.

SACRAMENTO, CAL.—Plans and specifications have been drawn for the remodeling of the Northern Electric Company's building at Eighth and J streets, the work to begin in early spring. The present walls of the structure will be torn down and a pressed brick and plate glass effect substituted. New tile flooring will be laid throughout the building and the heating arrangements and electric apparatus will be modern.

MEDFORD, ORE.—John R. Allen, who has held a franchise for a street railway, started work on it just 48 hours before the franchise expired. Two blocks of track on the main street were laid. No engineering work has been done, and no stakes set. A. Welch, 502 Fenton building, Portland, owns the Allen franchise. He has sent Jas. R. Thompson, an engineer, to Medford to start on this system, which will ultimately cover the entire Rogue river valley.

OAKLAND, CAL.—The statement of Vice-President E. E Calvin of the S. P. Co. that the proposed ordinance, passed to print two weeks ago, granting the railroad a franchise on Seventh street, was not approved by its president, has defeated the possibility of the awarding of the grant on the Oakland plan, as outlined by Chairman Ben H. Pendleton of the City Council. The matter will have to be entirely reconsidered, and will come up at the next meeting of the Council.

PETALUMA, CAL.—The Petaluma & Santa Rosa Electric Railway Company, through its president, E. M. Van Frank, has asked the Petaluma trustees to grant a franchise to the company for a line through this city. A. W. Bullard, the San Francisco representative of Rollins & Sons, financed the project to extend the local electric line to deep water. The terminus will be at Point Pedro, where it is proposed to have fast steamers meet the road and convey the passengers and freight to San Francisco.

STOCKTON, CAL.—After a long drawn out controversy the city trustees of Modesto have voted to advertise for sale the franchise asked for by the San Joaquin Valley Electric Railway. This means that the Brackett electric road, which is now pushing construction work on its line between Stockton and Modesto, will gain the desired entrance to the Stanislaus county seat. The franchise will be on Elm street, from the city limits to Eighth, on Eighth to F, with a spur for passenger purposes only from Eighth to Ninth on I street. At a meeting held the directors of the San Joaquin Valley Electric Railway was increased by the addition of Fred W. Rothenbush, the Stockton brewery man, and Andrew McCormick, the cattleman and meat dealer.

PORTLAND, ORE.—Ten acres of land have been purchased by the Portland Railway, Light & Power Company in southeast Portland upon which will be built the company's new car shops. The tract lies directly west of the large shops of the S. P. Co. The 11-acre tract at Powell and Twenty-sixth streets, bought recently by the company, will be used for a material yard with the intention of erecting car barns upon a portion of the land as the demand for shelter for the company's rolling stock increases. Vice-president F. I. Fuller is now having the plans for the new shops drawn up and that construction will be commenced as soon as possible. The shops will be built in units, the first unit to cost about $300,000. It will be a fireproof structure of brick or concrete. Other units will be added in accordance with the demand. One very important factor in industrial Portland will be the manufacture of cars instead of sending to Eastern or Middle States factories for them. Last year the company bought 120 new cars.

OAKLAND, CAL.—The plans of the United Properties Company to extend the Oakland Traction and Key Route systems to Sacramento and San Jose were revealed last week, when the incorporation papers of the Sacramento Short Line and San Jose Short Line Railways were filed. According to the plans of the corporation the Key Route system known as the San Francisco, San Jose and Oakland Railway, will be extended 98 miles into Sacramento, there to connect with the Northern Electric Company. The San Jose extension will be but a continuation of the Oakland Traction Company, whose lines at present terminate in Hayward. A franchise and rights of way have already been secured for the extension of this line into San Jose. The Sacramento Short Line is capitalized at $10,000,000 and the directors are attaches of the office of Gavin McNab, one of the incorporators of the United Properties Company. Of the capital stock, B. M. Aikens, McNab's chief aid, has subscribed $84,000, and the remaining directors, R. P. Henshall, Luther Elkins, George W. Mordecal, N. Schumlowitz, R. V. Whitney and F. L. S. Stewart, have subscribed $1000 each. The same directorate appears in the incorporation papers of the San Jose Short Line. The capital stock is fixed at $80,000.

ILLUMINATION.

ARLINGTON, ORE.—C. H. Busey has petitioned the Council to erect and operate an electric lighting plant in this city. The matter has been taken under advisement.

LONG BEACH, CAL.—The Towne Electric Company of this city will install electric power fixtures and lighting for the new Polytechnic and Academic high school. The company's bid is $5950.50.

TUSTIN, CAL.—Residents of Tustin have presented a petition to the Supervisors asking for the formation of a Pacific Highway Lighting District and a resolution has been adopted by the Board calling an election for February 6th to vote on the proposition of forming a district to be known as the Tustin lighting district of Orange County.

MERCED, CAL.—Mr. J. M. Berkley, consulting engineer of the San Joaquin Light & Power Company, visited here last week in connection with the plans which the company is making for the improvement of the gas system at Merced. This improvement will embrace the entire reconstruction and rebuilding of the old works. A new 75,000 cubic foot gas holder will be constructed and the mains throughout the city will be relaid and larger service pipes installed. The improvement will cost about $25,000, and work will begin next week.

SACRAMENTO, CAL.—One million dollars will be invested in the city of Sacramento by the Pacific Gas & Electric Company during the year 1911. This sum will be expended in erecting an auxiliary steam plant, in the improvement of the street railway service, in additions to the gas plant and in other betterments of the company's interests. The beginning of these expenditures has already been made and further work will be pushed as rapidly as possible. The plant for generating electricity by steam will of itself cost $500,000, exclusive of the lot upon which it will be located. The site has already been purchased and plans have been completed for the immediate construction of a steam turbine with an average capacity of 15,000 h.p.